United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

Part 612 Water Quality
National Resource Economics Handbook

Chapter 3 Quantifiable Impacts

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Contents:

612.0300 Introduction

To have measurable economic offsite impacts from conservation practices, an improvement in water quality caused by implementation of the practices must have occurred. Furthermore, these water quality improvements must enhance the value of the water resource.

612.0301 Water quality indicators

Many factors determine whether water quality is adequate for a specific use. These factors include type and quantity of pollutants, bacterial levels, requirements for designated uses, and such variables as streamflow, dissolved oxygen levels, temperature, pH levels, and aquatic habitat suitability. The term *water quality indicators* will be used in accordance with Principles and Guidelines to refer to factors that influence the suitability of water quality to a particular use.

A brief overview of water quality impairments and agricultural land use factors follows. Refer to the Water Quality Field Guide for information on the type and extent of impairment typically arising from each agricultural activity. The Field Office Technical Guide (FOTG) section III defines important water quality concerns.

Indications of poor surface water quality and factors that are frequently the causes include:

- Excessive algae growth—Measured by a chlorophyll "a" test and often caused by excess nutrients, such as nitrates and phosphates, entering a water body.
- Bacterial contamination—Frequently caused by untreated fecal matter.
- Sedimentation—Measured by lake clarity, turbidity, or Secchi Disk and often caused by excess erosion from the land.
- Low dissolved oxygen—Measured by BODs or DO tests and often resulting from high oxygen demanding substances, such as biodegradable organic matter, in the water.
- Presence of toxic compounds, such as pesticides, other organics or hydrocarbons, and heavy metals, resulting from their release and persistence in the environment.
- Other chemicals in excess of the assimilative capacity of the water body entering via land, air, or water.

Agricultural management deficiencies that may exacerbate pollution of surface water include:

- lack of erosion control on cropland, pastureland, and other land,
- failure to protect streambanks from animal trampling,
- fertilizer application beyond crop needs,
- poor animal waste management including spreading beyond the capacity of the land to use the nutrients, and
- inadequate animal carcass disposal practices.

Treatment measures that improve these practices improve surface water quality. Land treatment measures, such as filter strips, conservation tillage, pasture management, and animal waste management systems, lessen nonpoint source pollution of surface water. However, the system must be analyzed as a whole. Treatment measures for surface water quality may induce ground water pollution, such as if a dairy waste pond were to pollute an aquifer.

Poor ground water quality is indicated by high nitrate levels and contamination by pesticides, usually in shallow aquifers (less than 100 feet deep). The greatest cost of poor ground water quality is impairment of drinking water supplies. In some cases there can also be impacts associated with migration of the contaminant-laden water into other ecosystems (such as a contaminated spring with an outlet to a lake or stream).

Agricultural management deficiencies that lead to ground water pollution include excessive nitrogen applications, cultivation on extremely sandy soils or areas of limestone geology (sink holes), poor irrigation management, mixing and loading near wellheads without backflow prevention or proper well sealing, and high rates of pesticide application. Treatment measures that address these inappropriate practices will most likely improve ground water quality.

Descriptions of physical baseline and projected conditions need to include information relevant to social implications. Physical impacts perceived by users need to be articulated (e.g., the presence of algae in swimming holes). The economist can identify social implications of the physical impacts if he or she is involved early in the planning process. The other team members need to be aware of the type information required by the economist.

Key water quality economics questions are:

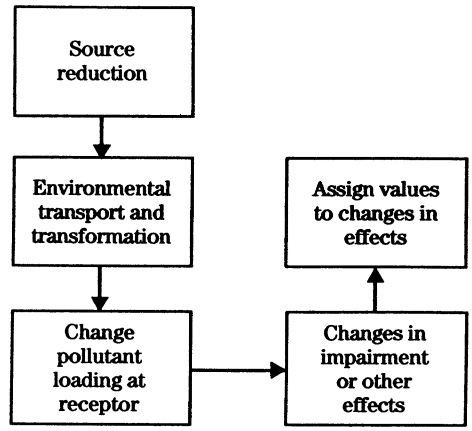
- What uses are impaired, e.g., contact recreation (swimming), noncontact recreation (fishing, boating), aesthetics, water supply (industrial, municipal, agricultural)?
- What ecological functions are impaired, e.g., for plants and animals?
- Who is affected, e.g., which user groups, whose property?
- What contaminants are responsible, e.g., nitrogen, phosphorous, BODs, suspended solids, toxics, volatile organics?
- What are the cause and effect relationships between the contaminants and uses?
- What are the areas of uncertainty?
- What risks do the contaminants pose, e.g., human health, animal health, plant health?
- Where do the contaminants come from and what are their absolute and relative magnitudes? The total pollutant load contribution from all sources should be identified and quantified as best as practicable.
- What are the time lags between implementation of source reduction measures and observation of water quality improvements?
- What other delays having economic consequences are there between treatment and response? (For example, if trees are planted on streambanks to improve stream temperature, there is a delay until the trees become effective and a further lag for fishing to improve.)
- What are "acceptable" (e.g., Federal, State, local criteria) pollutant levels? How much contaminant reduction is necessary to meet this level and to correct the impaired use?
- What are the physical, chemical, and biological changes associated with alternative treatment methods?
- What are the capital and operating and maintenance costs associated with alternative treatment methods?

612.0302 Impacts with economic value

Improvements of surface water quality and ground water quality often result in economic benefits. Water quality degradation has costs associated with impairment of designated uses and of indirect or secondary water uses, such as aesthetics and tourist enterprises. Designated uses of a water body can include agricultural water use, contact (swimming) and noncontact (boating and fishing) recreation, water supply, industrial water use, and other uses.

Figure 3–1 illustrates the cause and effect relationships of a change in water quality. Monetary values may be associated with the first box, source reduction, and the final box, where values are assigned. For example, the costs of a change in tillage practices enters into the economics of source reduction. The tillage practice changes reduce soil erosion and resulting sediment and nutrient loading into a stream system. The physical scientists determine the sediment and nutrient reductions and their effect on fish habitat and populations. They find that fish habitat in the nearby lake improves, which increases fish populations. The social scientists evaluate the lake's recreational use and how it has declined because of reduced fish populations. Increased fish populations caused by water quality improvements allow greater recreational use. The social scientists predict the amount of increased recreational use and estimate its value to society. Also, social scientists evaluate any other uses of the increased fish populations (commercial uses by Native Americans). Thus an interdisciplinary approach to cause and effect relationships is required.

Figure 3–1 From pollution control to economic impact



612.0303 Worksheet to list quantifiable impacts

Example 3–1 is a sample worksheet to list quantifiable impacts. Such worksheets could be developed for each agricultural practice typical of a locality. The worksheet would assist in enumerating onsite and offsite economic impacts before and after changes in management practices. The sample worksheet is for identifying water quality benefits from improved nutrient management for cropland, hay fields, and pasture.

Example 3–1 Sample worksheet—Water quality benefits from improved nutrient management

Describe impairments	Suppose seasonal algal blooms occur in a water body. At low flow conditions, the water is greenish. The quality of the water corresponds to the classification of **fair** (Field Sheet 3A, Water Quality Indicators Guide: Surface Waters). The impairments could include clogged pipes, water supply taste, color or odor, cattle abortion, reduced recreational use, or other impairments (from Field Sheet 3A, Water Quality Indicators Guide: Surface Waters).
Identify the causal links	Are the impairments caused by practices that would changeas a result of a proposed project? If some impairment would not be mitigated because of the project, then no project benefits would be attributable to that use category.
Characterize the options for treatment and/or new management systems	Costs of treatment options would be calculated following the guidelines in Part 630 of the Economics Handbook (in draft).
Describe impacts in quantitative terms	An evaluation of how uncertainties could influence the range of impacts would be included in this description. Impacts would need to be allocated by treatment measure for purposes of incremental analysis.
Enumerate the onsite and offsite benefits	For example, the following onsite and offsite market and non-market impacts may occur from improved nutrient management systems for cropland, hay fields, or pasture.

Example 3–1 Sample worksheet—Water quality benefits from improved nutrient management—continued

Market benefits onsite:

- *Qualitative description of benefits*—Purchases of fertilizer inputs would be reduced. Crop yields may change. Management time may increase. There may be fewer cattle abortions.
- *Estimated value to farmer (onsite stakeholder)*—Estimate cost savings, revenue changes, and the value of changes in time inputs. Estimate value to farmer of reduced cattle abortions.

Market benefits offsite:

- *Identification of affected parties (stakeholders)*—Municipal and industrial water suppliers benefit from the improvement.
- *Qualitative description of benefits*—Intake pipes clog up less.
- *Estimated value (by stakeholder group)*—Estimate cost savings from reduced operation and maintenance costs.

Non-market benefits offsite:

- *Identification of affected parties (stakeholders)*—Recreational anglers benefit from improved water quality. Other recreational users whose use is curtailed due to weeds or unpleasant odors attributable to the nutrient loading benefit if nutrient loading is curtailed. People benefit who value fish habitat quality (even if they don't fish).
- *Qualitative Description of Benefits*—Greater recreational use occurs, and intrinsic benefits are higher.
- *Changes in Risks*—Health risks do not change. Risk of species decline falls.
- *Estimated Value*—Using Unit Day Values or results from previous non-market valuation studies, what range of change in user days is predicted for each recreational activity? What would be a conservative estimate of non-use benefits, e.g., the value of decreasing the risk of species decline? Such non-use benefits are described in chapter 4.

Summary of benefits, costs and risks, and their distribution:

- Which options yield the greatest benefit per expenditure?
- If the benefit estimates are highly uncertain, which options cost the least for comparable improvements in water quality?
- Do benefits exceed costs? Are benefits, costs, and risks to farmers such that they will most likely voluntarily adopt the measure(s)?

Summary of impacts on the four accounts:

- National Economic Development account with and without the project.
- Regional Economic Development account with and without the project.
- Environmental Quality account with and without the project.
- Other Social Effects account with and without the project.